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Articulating societal benefits in grant proposals: Move analysis of Broader Impacts

Elena Cotos
Iowa State University, ecotos@iastate.edu

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Keywords
Move analysis, Grant proposals, Part-genre, Broader Impacts, Corpora

Comments
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Abstract

Being 'scholarly' includes the pursuit of grants, which requires understanding and satisfying the review criteria of individual funding organizations. An important merit review criterion against which the National Science Foundation (NSF) evaluates grant proposals is Broader Impacts (BI). The two-fold purpose of this study was to 1) identify the rhetorical conventions of stand-alone BI sections, which are expected to demonstrate the potential of a proposed project to benefit society, and 2) compare the use of rhetorical conventions in the BI sections of funded and non-funded proposals. In the tradition of genre theory, the study employed a top-down move analysis of a corpus of 91 BI texts from proposals in different disciplines submitted to the NSF. The analysis yielded a descriptive model of 3 moves and 9 steps, named Contextualize-Demonstrate-Predict, which was applied to the annotation of the entire corpus. Descriptive and statistical analyses of the annotated data provided a rich description of the composition of BI discourse in terms of primary and secondary rhetorical functions, also revealing similarities and differences in move and step distribution, functional prominence, and language use in the BIs of funded and non-funded proposals. The results of this study lend themselves to practical implications for grant writer education in rhetorical competence.

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1. Introduction

Extramural funding has become the largest source of support for potentially transformative academic research. In the United States, the National Science Foundation (NSF) alone, with a $7.5 billion annual budget, is the funding source of roughly 24% of the federally supported research in science, technology, engineering, and mathematics disciplines (National Science Foundation, 2017). It funds approximately 11,000 of 40,000 proposals submitted by colleges and universities each year. Securing grants is not only extremely competitive, but also depends on how well proposers address the expectations of target funding agencies which, both nationally and internationally, no longer expect public investments in science to automatically contribute to social and economic goals. In other words, in addition to demonstrating how their projects will advance knowledge, proposers have to describe what social benefits their new scientific discoveries can bring. In Europe, for example, the European Commission thoroughly considers social effects when reviewing proposals submitted to its Framework Programs for Research. England's Higher Education Funding Council assesses proposed research partly based on its demonstrable economic, social, or cultural benefits. In the United States, the National Institutes of Health, the National Aeronautics and Space Agency, and the Gates Foundation – all expect the proposed research to be responsive to societal needs (Davis & Laas, 2014). The NSF is similar in this respect.

The NSF evaluates grant proposals in terms of integrated and interdependent Intellectual Merit (IM) and Broader Impacts (BI) criteria. The former deals with the scientific quality and

significance of the proposed research. The latter focuses on the project's anticipated benefits to society. Since the NSF first began awarding funding in the early 1950s, it has continuously emphasized and refined its merit review criteria. In 2010, the US Congress passed the America COMPETES Reauthorization Act that, among other things, refunded the NSF and mandated the BI review criterion. Effective January 2013, the NSF made significant changes in the Proposal and Award Policies and Procedures Guide, according to which grant applicants must describe activities proposed to achieve societally beneficial outcomes in a separate section labeled 'Broader Impacts.'

While the BI criterion speaks directly to the mission of the NSF to advance the national health, prosperity and welfare, its definition is rather broad and frustratingly vague (Lok, 2010), which is why the community-wide understanding of it has been weaker compared to the IM criterion. Confusion persists about how the BI criterion is applied, how it should be interpreted, and how to address it when writing a proposal (Intemann, 2009; Roberts, 2009; Sarewitz, 2011). Lok (2010) explains that the lack of conceptual clarity leaves researchers unsure about what to include in their BI sections and leads to inconsistencies in how reviewers evaluate proposals. To address this issue, the NSF launched efforts to educate grant applicants about BIs through websites, workshops, conference sessions, and annual summits hosted by the National Alliance for Broader Impacts (NABI). At Iowa State University in the USA, such efforts have been led by the Strengthening the Professoriate Initiative (SP@ISU), whose mission is to support faculty and students as they develop BI plans for NSF proposals.

Similar to Connor and Mauranen (1999) who analyzed the conventions of grant proposals as a text genre in order to produce a guide book for writing successful proposals for European Union Research Grants, the study reported in this article was motivated by the need to develop resources for composing effective BI sections (BIs) for NSF proposals. Being a separate section of the proposal, BIs can be considered a part-genre, as are Introductions in research articles (Dudley-Evans, 1997). To support this assumption, the primary goal of this study was to identify the genre characteristics of BIs and to examine their rhetorical composition. The second objective was to compare BIs in funded and non-funded NSF proposals and to determine whether there are salient differences in rhetorical conventions and language use. Investigating possible distinctions was driven by the same need to inform educational efforts supporting NSF proposal writing, rather than by the supposition that the BI component is the main determining factor for proposal acceptance.

2. Grant proposals and genre analysis

2.1. The genre system of grant funding

This work adopts genre analysis – "the study of texts as social phenomena where recurrent patterns of structure and behavior help organize structures and behaviors into comprehensible and effective forms" (Connor & Mauranen, 1999, p. 48). Swales (1990) sees genres as pertaining to socio-rhetorical networks called discourse communities. Operating across different discourse communities, genres do not live in solitude but rather coexist interactively with other genres. Scholars from different perspectives of genre theory[1] concur that genres can cluster into genre families (Hasan, 1985), genre sets (Devitt, 1991), intertextual systems (Bazerman, 1994), and

[1] See Johns (2008) for a comprehensive overview of genre theory in English for Specific Purposes, Systemic Functional Linguistics, and New Rhetoric.

colonies (Bhatia, 2004). Their shapes and goals are dynamic and varied. Another characteristic is that genres are conventional in that they exhibit "central tendencies" repeatedly occurring in texts (Johns, 2008, p. 241), as they represent ideological and epistemological values of given discourse communities (Berkenkotter & Huckin, 1995). The conventions are identifiable as helping to accomplish communicative purposes that are achieved through so-called rhetorical values or strategies (Bhatia, 2004; Johns, 2008). In English for Specific Purposes (ESP), descriptions of different genres draw on Swales' analytic paradigm which, with a focus on macro-structure and textual features, enables the development of rhetorical-linguistic frameworks of functional discourse units; i.e., communicative goals called *moves* and rhetorical strategies called *steps*.

The grant proposal belongs to a complex genre system of academic research funding. Tardy (2003) explains that it spans multiple contexts and discourse communities, including the funding agency, program officers, professional community as well as the principal investigator's colleagues, office of institutional sponsored programs, and the university. When preparing a grant application, applicants in fact engage with a genre set which, in addition to the proposed project description, includes a number of interrelated artifacts (e.g., cover sheet, project summary, budget, current and pending support, data management plan, graduate or postdoctoral mentoring plan, etc.). The funding agency as well as the proposer's institution put forth their own genre sets (e.g., mission statement and support documents, respectively). Together, these form "an intertextual system that both creates and is created by the social interactions of the system" (Tardy, 2003, p. 23). Given the complexity of this system, the grant proposal is described metaphorically as "genre-as-struggle" (Tseng, 2011, p. 2260), where generic textual conventions are an integral dimension interconnecting the pragmatic performance of the proposer and the cognitive and socio-cultural expectations of the addressee. The understanding of such conventions is thus imperative for both producing and evaluating grant applications.

2.2. Conventions of grant proposal discourse

Given that grant proposals aim to persuade, they are associated with promotional genres and thus share similar rhetorical conventions with advertisements, sales letters, job applications, and philanthropic discourse. Both ethnographic and text analysis approaches have been used to study promotional discourse, focusing on social contexts (Myers, 1997), cultural differences (Graves, 1997), and rhetorical structure (Abelen, Redeker, & Thompson, 1993). Bhatia (1998) advocates one of the most prolific approaches – Swalesian genre analysis of functional discourse units. He outlines the most common moves in promotional texts (*Establishing Credentials, Introducing the Cause*, *Soliciting Support*, and *Expressing Gratitude*) and demonstrates how these moves are realized with a variety of step strategies (e.g., referring to community needs, describing the cause, appeals for support, and reaffirming mission statements, respectively). Considering these moves and steps, Bhatia argues that promotional discourse offers a "challenging profile of linguistic realizations to achieve a limited set of generic objectives" (Bhatia, 1998, p. 100).

In academic contexts, grant proposals are a research genre. The move composition of grant proposals is similar to conference proposals and research articles (Halleck & Connor, 2006). The moves outlined in Swales' (1981, 1990) CARS model for research article Introductions have been found in the Project Description sections of grant proposals as well as in their abstracts and summaries. Table 1 exemplifies the move models developed for full proposals and their part-genres (Dudley-Evans, 1997), showing that they share a repertoire of moves and steps, many of which are the same as those in the CARS model. This similarity in communicative purposes

makes grant proposals part of what Bhatia (2004) calls the genre colony of academic Introductions.

Table 1
Overview of Moves in introductions and in grant proposals, summaries and abstracts.

Research article introduction (Swales 1981)	Grant proposals (Connor and Mauranen 1999)
Move 1. Establishing a Territory	Move 1. Territory
Step 1. Claiming centrality	Move 2. Gap
Step 2. Making topic generalization/s	Move 3. Goal
Step 3. Reviewing items of previous research	Move 4. Means (methods, procedures)
Move 2. Establishing a Niche	Move 5. Reporting Previous Research
Step 1a. Counter-claiming	Move 6. Achievements
Step 1b. Indicating a gap	Move 7. Benefits
Step 1c. Question-raising	Move 8. Competency Claims
Step 1d. Continuing a tradition	Move 9. Importance Claim
Move 3. Occupying the Niche	Move 10. Compliance Claim
Step 1. Outlining purposes	
Step 2. Announcing present research	
Step 3. Announcing principal findings	
Step 4. Indicating article structure	

Grant summaries (Feng and Shi 2004)	Grant abstracts (Feng 2008)
Move 1. Justifying a Research Need	Move 1. Establishing a Territory
Step 1. Establishing a real-world/research territory	Step 1. Centrality claim
Step 2. Indicating a niche	Step 2. Topic generalization
Step 3. Reporting on the proposers' previous research	Step 3. Reporting on the proposers' previous research
Move 2. Describing Means to Meet the Research Need	Move 2. Establishing a Niche
Step 1. Outlining research objectives	Step 1a. Counter-claim
Step 2. Describing research methods	Step 1b. Indicating a gap
Move 3. Claiming Potential Contributions	Step 1c. Question-raising
Step 1. Claiming importance	Move 3. Outlining Research Objectives
Step 2. Claiming achievements	Move 4. Describing Research Means
Step 3. Claiming benefits	Move 5. Explanation and Justification
	Move 6. Claiming Potential Contributions (achievement and benefit claims)

It is worth mentioning that the moves or steps found in grant (part-)genres but not in academic introductions tend to align with promotional genres (Bhatia, 2004). For example, *Competency Claims* in grant proposals (Connor & Mauranen, 1999) resonate with *Establishing Credentials* in job application letters and personal statements (Bhatia, 1993, Ding, 2007). Similarly *Describing Means* and *Claiming Potential Contributions* in grant abstracts and summaries (Feng, 2008; Feng & Shi, 2004) are comparable to *Introducing the Cause* in direct mail fundraising letters (Bhatia, 1998; Upton, 2002) and *Indicating Value of Offer* in sales letters (Bhatia, 1991).

Existing move analysis studies have been very informative. Corpus-based analyses in particular shed light on move distribution, frequency, length, and linguistic and disciplinary variation (Connor, 2000; Connor & Upton, 2004). However, the understanding of the research grant discourse in view of all its internal components is still limited. Additionally, because

applicants are often reluctant to release their proposals, it is difficult to collect representative corpora of proposals submitted to specific agencies in specific socio-cultural and geopolitical contexts. Therefore, investigations of the research grant proposal genre set and the interrelations among its integral artifacts have relied on a relatively small number of proposals.[2] Another limitation is non-congruency in the use of the units of analysis; in other words, some studies focus on moves and others differentiate between moves and steps, which sometimes overlap (e.g., the notion of *Territory* appears both as a move and a step in Table 1). Furthermore, Flowerdew's (1998, p. 549) remark that, when it comes to corpus annotation, "little has been done on the semantic or pragmatic discourse level" applies to grant proposals as well. Therefore, in the tradition of Swalesian genre theory, this study employed move analysis and corpus annotation to investigate the rhetorical conventions of BIs in NSF proposals.

3. Methods

3.1. The BI corpus

The BI corpus was derived from a collection of 119 proposals submitted to the NSF between 2005 and 2012. These proposals were collected by the SP@ISU initiative with approval from the Institutional Review Board. The SP@ISU informed the faculty at Iowa State University of their goal to develop resources for effective BI writing in order to support faculty as they prepare NSF proposals. A representative from SP@ISU invited the faculty who had submitted to the NSF to send their proposals to her (no incentive was offered) and stored them in the initiative's repository. The proposals that were received represented submissions to six NSF directorates: Engineering; Computer and Information Sciences; Biological Sciences; Social, Behavioral, and Economic Sciences; Mathematical and Physical Sciences; and Geosciences.

All the documents were de-identified and renamed. Each file name included meta-data as follows: genre (GP for grant proposal), funding status (F for funded, NF for non-funded, or A for awaiting), and number of text (e.g., GP_F_9). Then, the BI components were separated into individual text files, which were named in a similar way: funding status (F, NF, or A), part-genre (BI), and text number (e.g., F_BI_9). Only 91 proposals had identifiable BI content; 81 proposals contained separate sections called Broader Impacts, and 10 proposals contained BI-related subsections (Significance and Impact, Objectives and Significance, Impact on Research and Training Infrastructure, Expected Project Significance and Education Plan, Educating a New Scientific Workforce). This difference was recorded in the file names for the latter, which contained NBI, i.e. not BI, in the file name (NF_NBI_6). Of the 91 proposals, 41 were funded, 43 were not funded, and 7 were awaiting a decision. Size-wise, this BI corpus contained a total of 2,240 sentences, 49,016 words, and an average of 606 words per text.

3.2. Analytical procedure

The investigation of moves and steps unfolded in phases: I) qualitative analysis of BI discourse to develop a move/step model, II) BI corpus annotation for moves and steps, and III) quantitative analysis of the annotated data in the BI corpus as a whole, as well as in funded and non-funded proposals.

[2] Connor (2000) and Connor and Mauranen (1999) are among the few studies that present substantial analyses.

Phase I began with the inductive analysis of a random sample of 46 BIs, which included texts from all six directorates. The analysis was done by exploring both the rhetorical and content aspects of these texts in view of the two merit review criteria – Broader Impacts and Intellectual Merit – as described by the NSF in the Proposal and Award Policies and Procedures Guide. For example, according to these criteria, the applicants were expected to establish the potential of the proposed project by presenting a sound rationale and a well-organized plan for exploring original concepts, incorporating a mechanism to assess success, and demonstrating the team's qualifications and availability of adequate resources. Another important source of reference was a list of representative BI activities (see examples in Appendix A), which were publicly available as a proposal preparation resource. This resource illustrated activities that, when successfully incorporated in the text, were considered to be helpful for reviewers and the NSF program staff in addressing the BI criterion in the review and decision process.[3] Drawing on these artifacts of the genre set was necessary in order to understand how the proposals presented societally relevant outcomes content-wise.

Second, the top-down approach to corpus analysis was employed, which is comprehensively described and widely adopted in ESP genre analysis (Biber, Connor, & Upton, 2007; Cotos, 2018). At this stage, the texts from the same sample were segmented into excerpts that realized a discernable global communicative goal. The excerpts were further examined to distinguish their local discourse functions, after which relevant categories were grouped into tentative moves and steps. Third, these tentative categories were used in pilot-coding the BI sample, and move/step definitions were devised based on a set of materials created in this process (e.g., rhetorical interpretations of coded segments, content information, representative examples, and functional language indicative of rhetorical intent). Fourth, the move/step definitions and examples were discussed with two university professors who were co-principal investigators for NSF grants obtained to establish NABI and SP@ISU, and had extensive NSF grant writing and reviewing experience. Their expert input helped assess the appropriateness of each move/step category and address issues of clarity and conceptual duplication, thus serving to refine and validate the BI move/step model.

In Phase II, all the texts in the BI corpus were manually annotated using the new BI move/step model, following a protocol and the step descriptors developed as a result of pilot coding (see Appendixes B and C). As in Cotos, Huffman, and Link (2017), the unit of annotation was considered a functional segment of text, which could be either a full sentence, a clause, or a phrase within a sentence. Similar to Moreno and Swales (2018), the annotation was multi-layered. Sentences that carried one functional meaning were assigned one move and one step. If a sentence carried more than one functional meaning, the overall function of the full sentence was assigned a step and a move, and the part of the sentence that carried additional functional meaning was tagged with an additional step and move. This way, the annotation at full sentence level marked the primary function, and the additional annotation layer marked the secondary function of such sentences. In the case of a paratactic clause complex with coordinate clauses, the same primary step and move was assigned if the clauses carried the same functional

[3] The Proposal and Award Policies and Procedures Guide can be accessed at https://www.nsf.gov/pubs/policydocs/pappg18_1/pappg_3.jsp#IIIA. The example BI activities were downloaded from https://www.nsf.gov/pubs/2002/nsf022/bicexamples.pdf. The NSF removed them from public access after the changes to the Proposal and Award Policies and Procedures Guide were made.

meaning; if not, each clause was tagged with a respective primary step and move. When clauses were related hypotactically in terms of subordination or embedding, the dependent clause was tagged with a secondary step and move if its function was different from that of the main clause. (Examples are provided in the Results section.)

Apart from instructions for determining primary and secondary functions, the annotation protocol also outlined guidelines for determining consistent unit boundaries, resolving annotation issues (e.g., functional ambiguity, lack of clear rhetorical signals, implicitness of expression), conducting reliability reviews, and using the Callisto annotation software (https://mitre.github.io/callisto). The corpus was annotated by two trained research assistants, who had also been engaged in Phase I of the study. To verify unit boundaries and functions, the annotations of every single text were discussed and confirmed in weekly adjudication sessions.

In Phase III, the occurrences of moves and steps were quantified for the BI corpus as a whole and for funded and non-funded proposals separately.[4] In addition to percent calculations and independent samples t-test comparisons, the quantitative data were used to visualize the distribution and sequence of moves in individual texts using the Plotly Python Library of Plotly (https://plot.ly), which is a data analytics platform that provides open source tools for generating and sharing interactive data visualization via the Web. Another level of analysis consisted of extracting n-grams (uni-grams, bi-grams, and tri-grams)[5] that occurred more than twice and conducting Bootstrap Consensus Tree analysis using the Stylo package in the R environment for statistical computing and graphics. The bootstrap procedure runs different (virtual) cluster analyses and synthesizes the results through a network visualization as a single consensus tree. The tree represents the topology of the most frequently appearing branch groupings, which is interpretable in view of the "nodes for which there exists a sufficiently large consensus among the individual cluster analyses" (Eder, Rybicki, & Kestemont, 2016, p. 114).

4. Results

4.1. Genre characteristics of BI sections

The first objective of this study was to identify the rhetorical conventions of BI discourse. This section introduces a move/step model for BI writing, whose categories are described in terms of functional, content, and linguistic realizations. Then, the move/step composition of the BI corpus is reported.

4.1.1. Contextualize-Demonstrate-Predict (CDP) move/step model

The top-down corpus analysis resulted in a move/step model, henceforth termed Contextualize-Demonstrate-Predict (CDP), which contains 3 moves and a total of 9 steps (Fig. 1). In what follows, I first provide move and step definitions and examples. Then, I describe the rhetorical composition of the BI corpus based on move and step frequencies.

[4] Cross-disciplinary comparisons were not conducted because NSF directorates and programs are not focused on homogeneous disciplines. Also, it would be wrong to assume that all the proposals submitted, for instance, to the Engineering directorate are submitted only by engineers.
[5] The n-grams were extracted using the open-source Online NGram Analyzer tool (http://guidetodatamining.com/ngramAnalyzer).

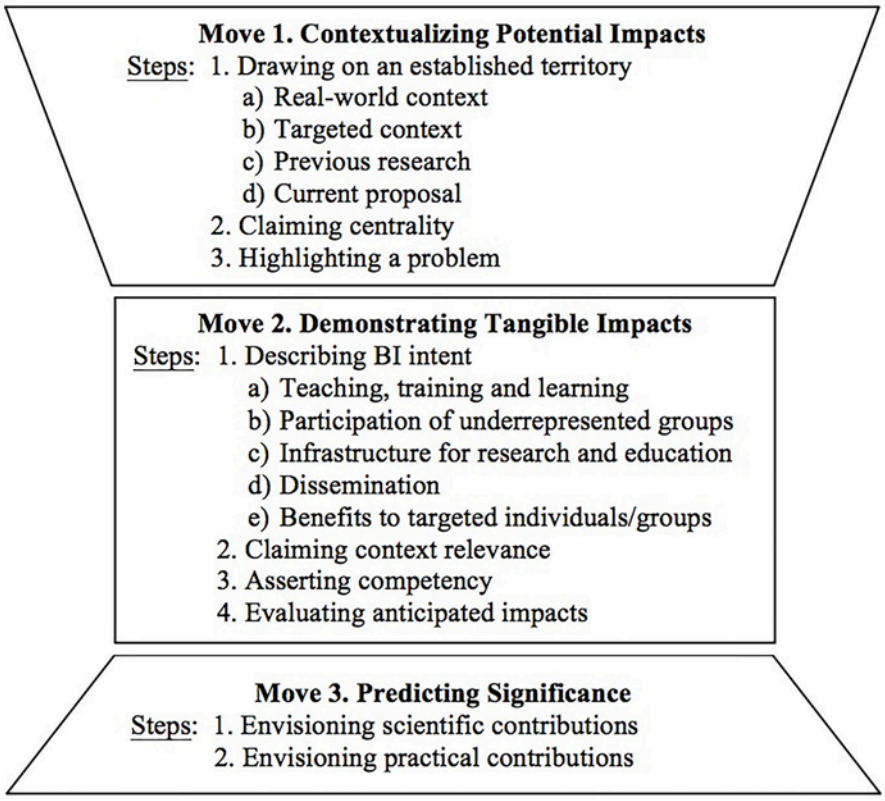

Figure 1. Contextualize-Demonstrate-Predict model for BI sections in NSF grant proposals.

Move 1: Contextualizing Potential Impacts foregrounds BI claims with background information that is of relevance to the proposed research and the follow-up BI activities. Authors typically integrate details relevant to the subject topic, supporting them with evidence derived from empirical research or other credible sources that suggest need and potential for societal impact. Such information is provided not only to build a frame of reference for the proposed BI activities, but also to implicitly emphasize the importance of the proposed work for real-world problems and to present the BI activities as opportunities to address those problems.

Step 1, Drawing on an established territory, relates proposed BI activities to the state of affairs or specific needs in the real world or in a particular context targeted in the proposal (see sub-steps 1a-1d in Figure 1). It may also demonstrate needs as identified by previous or proposed research. Content-wise, it can be realized by providing: domain-specific, factual, policy-related information; descriptive details about the population and participating units targeted by proposed BI activities; empirical insights; and links between proposed research and anticipated impacts.

- Example: "In 2009, to meet the goal of a higher level of public literacy in complex environmental systems, the NSF Advisory Committee for Environmental Research and Education (ACERE) posed several significant pedagogical research questions." (F_BI_16)

Step 2, Claiming centrality, is the same as in Swales' CARS model in that it affirms that the topic addressed in the proposal is important. Centrality statements emphasize prominence as well as increased interest in the topic.

- Example: "With the potential retirement of nearly 50% of the […][6] workforce in the next 10 years [48], such plans for broadening participation in […] is critical for our national and economic security." (NF_BI_83)

Step 3, Highlighting a problem, also pertaining to CARS, specifies a problem in the established territory that poses challenges to particular areas in real-world and/or target contexts. Its content realization includes societal controversies, difficulty in finding solutions, limitations of previous research, practical challenges, potential negative consequences, etc.

- Example: "Increasing […] prices to this extent can cause immeasurable harm to the nation's economic vitality." (NF_BI_31)

Move 2: Demonstrating Tangible Impacts describes planned BI activities and demonstrates how those activities will exert concrete benefits via intended means of implementation as well as use of relevant resources, expertise, and evaluation measures.

Step 1, Describing BI intent, serves as a direct response to the BI merit review criterion by specifying activities, means of implementation, and deliverables that are expected to lead to positive impacts in the context of the proposed project. The BI activities are typically related to the NSF's expectations: improved teaching, training and learning; increased participation of underrepresented groups; enhanced infrastructure for research and education; increased partnerships between academia, industry, etc.; broad dissemination; specific benefits to targeted individuals/groups; improved national security; and increased economic competitiveness. (These ideas are reflected by the sub-steps 1a-1e in Figure 1.)

- Example: "Through active recruiting of minority and women graduate students from REU sites, partner institutions, and […] and […] programs at [...], the […] program will involve a diverse set of participants." (F_BI_61)

Step 2, Claiming context relevance, demonstrates that the targeted context/s is/are appropriate for and indicative of successful implementation of the proposed BI activities. Context relevance can be established through descriptions of advantageous initiatives, resources, technologies, existing partnerships as well as evidence of support from stakeholders or existing partnerships.

- Example: "The […] Department has an excellent foundation on security research via the well-recognized […]-designated […] Center." (F_BI_4)

Step 3, Asserting competency, argues that the proposers' expertise, teaching and mentoring experience, reputation, prior grant activity, and other achievements underscore the future success of the BI activities.

- Example: "The research team is well positioned to transfer the knowledge and practical insights to […] management agencies with whom they have been actively interacting through several large-scale activities carried on in […]." (F_BI _79)

Step 4, Evaluating anticipated impacts, indicates how the effects of the proposed BI activities will be assessed. For that, proposers specify approaches and make predictive claims of effectiveness of outcomes.

[6] Square brackets are used as placeholders replacing information removed for the purpose of de-identification (e.g., names, units, institutions, specific innovations, etc.)

- Example: “On the website, we will collect information on […] and deliver follow-on questionnaires to those using the materials to obtain more details of the program impact.” (NF_BI_78)

Move 3: Predicting Significance aims to argue that the proposed project will have valuable large-scale societal implications, which are believed to expand beyond tangible impacts to wider scientific and practical applications.

Step 1, Envisioning scientific contributions, claims the value of new scientific discoveries by predicting notable advancements and applicability of findings for future research inquiries.

- Example: “The proposed […] framework will bring to the science community a new perspective and an invaluable tool for studying the functions of […] that are constantly in motion.” (A_BI_57)

Step 2, Envisioning practical contributions, claims significant potential to achieve desired societal outcomes. It can be realized by predicting contributions of science to welfare, security, public policy, health, environment, critical situations, decision-making, etc.

- Example: “Ultimately, technological innovations of this sort will be required for our nation to achieve independence from foreign […] reserves.” (NF_BI_40)

As can be gathered from the examples above, the functional meanings of the moves and steps (henceforth abbreviated as M/S) identified in the BI corpus are generally realized with identifiable language choices. Table 2 contains representative examples from the top 10% of the occurrences of tri-grams. Except for *Drawing on an established territory* (M1/S1), the functional language of the steps is largely argumentative: persuasive (M1/S1; M2/S2,S3), negative (M1/S3), promising action (M2/S1; M3/S2), evaluative (M2/S4), and assuring (M3/S1,S2) (see Table 2).

Table 2
Language choices expressing the functional meanings of moves and steps.

Moves_ Steps	Language	Examples
M1_S1	general, neutral, specialized	in the context of, are found in, is generally used, is primarily captured, key findings from, are comprised of, results indicate that, has shown that, need identified by, meet the goal, of the program, the aim is, the understanding of
M1_S2	persuasive	it is important, is the essential, of utmost importance, is critical for, has been growing, increasingly interested in, of considerable interest, has become important, essential component of, is potentially significant, a growing emphasis,
M1_S3	negative	however it is, is a classic problem, a significant challenge, is poorly known, a major concern, increasing pressure to, adverse impact on, cause substantial harm, serious shortage of has been controversial, attempts have failed
M2_S1	promising action	will develop in, will be delivered, will be integrated, will be recruited, will be performed, will be completed, will be established, will provide experience, will be engaged, will be disseminated, will enhance, make freely available

M2_S2	persuasive	has a strong, is extremely competitive, been in place, for numerous years, includes extensive training, has seen a dramatic increase in, has already developed, one of the, highest enrollments of, an exponential number
M2_S3	persuasive	long track record, collaborated extensively with, prior success with, been recognized by, decades of experience, highly successful in, obtaining extramural grants, previously implemented via, active in publishing, is an active
M2_S4	evaluative	we will assess, we will examine, we will have, use feedback from, determine the usefulness, evaluate performance by, test the outcomes, obtain information from, will also be, analyze evaluation results, collect and prepare, a summary evaluation
M3_S1	assuring	this will enhance, this will foster, a novel framework, significantly advance the, increase fundamental knowledge, advance research capabilities, provide invaluable insights, lead to advancements, improve our ability, has the potential, synergize with research, new theoretical model
M3_S2	assuring, action	of value to, extend outside the, positive impact on, allow for the, will create measurable, in the long term, can lead to, be broadly applicable, will significantly change, may facilitate the, potential to greatly, could be expanded, first step toward

Interestingly, although not surprisingly, the choice of verb tenses is related to specific rhetorical functions. For instance, present and present perfect were used to persuade proposal reviewers that the needs were central (M1/S2), the problems were serious (M1/S3), the context was relevant (M2/S2), and proposers possessed the necessary expertise (M2/S3). Similarly, 'will' predominated in claims that promised implementation of specific BI activities (M2/S1), assessment of their effectiveness (M2/S3), and assurance of future contributions (M3/S1,S2).

4.1.2. CDP move/steps in the BI corpus

Once annotated with the CDP moves and steps, the corpus data allowed for a quantitative analysis of the rhetorical composition of the BI corpus. In total, 2262 units were annotated: 25% (573 units; 11147 words) were tagged with M1, 66% (1481 units; 32852 words) with M2, and 9% (208 units; 5017 words) with M3.

As mentioned in Section 3, multi-functional units were assigned more than one move and step to capture primary and secondary functions. As shown in the following example, an entire sentence was coded as Move 2, *Demonstrating Tangible Broader Impacts* and one of its steps, *Describing BI intent* (sub-step *Teaching, training and learning*) as indicating the primary function. The latter part of this sentence was tagged with a secondary step function of Move 2, *Asserting competency*.

- "At [University], [Name] will extend an existing science outreach program to include plant genomics managed by [Name] who provides biotechnology training for secondary teachers through [Title] grant support." (F_BI_113)

Annotation:

- *<BI_m2_Demonstrating_Tangible_Broader_Impacts step="BI_intent_Teaching_training_learning">*At [University], [Name] will extend an existing science outreach program to include plant genomics managed by *<BI_m2_Demonstrating_Tangible_Broader_Impacts step="Asserting_competency">* [Name] who provides biotechnology training for secondary teachers through [Title] grant support*</BI_m2_ Demonstrating_Tangible_Broader_Impacts>*.

Table 3 shows that the 91 BIs operated with both primary and secondary functions in each move to a comparable degree (number of units given in parentheses). This may suggest that, in order to present claims more effectively in a short amount of text, proposers attempted to rhetorically load most of their sentences. M2, *Demonstrating Tangible Impacts*, is the most frequent irrespective of primary or secondary functional prominence.

Table 3
BI corpus moves coded with primary and secondary functions.

	All BIs (91)		
	Primary	Secondary	Total
M1	24% (450)	34% (123)	25% (573)
M2	67% (1272)	58% (209)	66% (1481)
M3	9% (177)	8% (31)	9% (208)
Total	100% (1899)	100% (363)	100% (2262)

Within each move, certain steps occurred more frequently than others. Figure 2 summarizes the overall distribution of steps. Not surprisingly, M2/S1 *Describing BI intent* constitutes 47% of the discourse units in the BI corpus. In the other two moves, M1/S1 *Drawing on an established territory* (18%) and M3/S2 *Envisioning practical contributions* (6%) had a larger proportion.

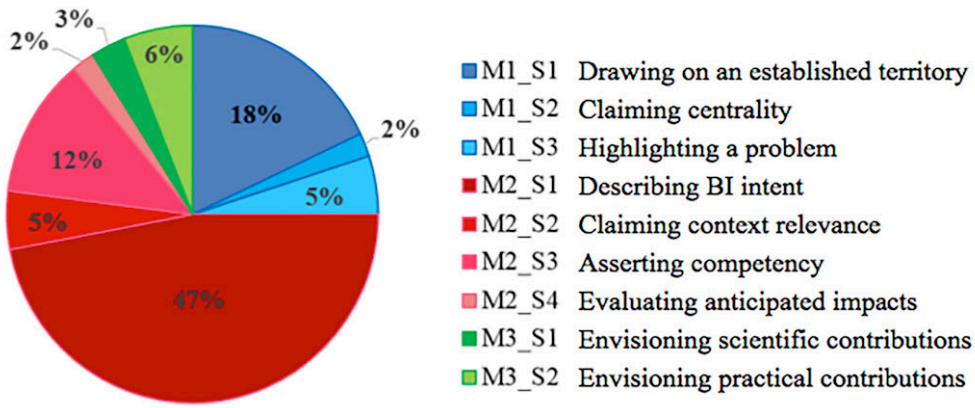

Figure 2. Distribution of steps in the BI corpus.

4.2. Rhetorical conventions of BIs in funded and non-funded proposals

The second objective was to examine whether there are distinguishable differences in terms of how funded and non-funded NSF proposals employed rhetorical moves and steps in BI discourse. Therefore, here I present findings derived from the annotated sub-corpora of funded and non-funded BIs (excluding the texts from proposals awaiting decision). The comparison

focuses on similarities and differences in move and step distribution, functional prominence, and language use.

4.2.1. Move distribution

Figures 3a, 3b and 3c generated with Plotly visualize the distribution of moves in each BI text in funded and non-funded proposals, respectively. For clarity, Figure 3a zooms in to visualize the move composition of one text, showing the move names next to each color and the number of units coded with that move in each color strip. In figures 3b and 3c, each bar represents one BI text; the end of the bar marks the end of the text. Blue, red, and green colors stand for M1, M2, and M3, respectively. Judging from the distribution of the three color shades of the three BI moves in Figures 3b and 3c, there is considerable internal variation in the move composition of BI sections. More than half of the BIs in both sub-corpora contained all three moves: 27 BIs (66%) in funded proposals and 34 BIs (79%) in non-funded proposals. Only one BI text in each sub-corpus contained only Move 1. Most of the texts composed of two moves contained Move 1 and Move 2.

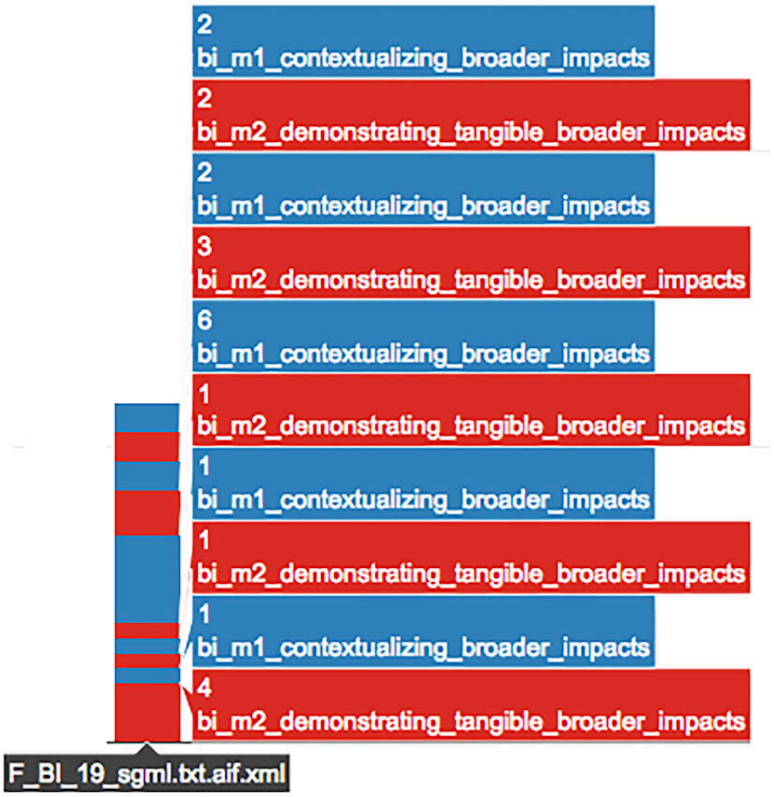

Figure 3a. Move structure of one BI text.

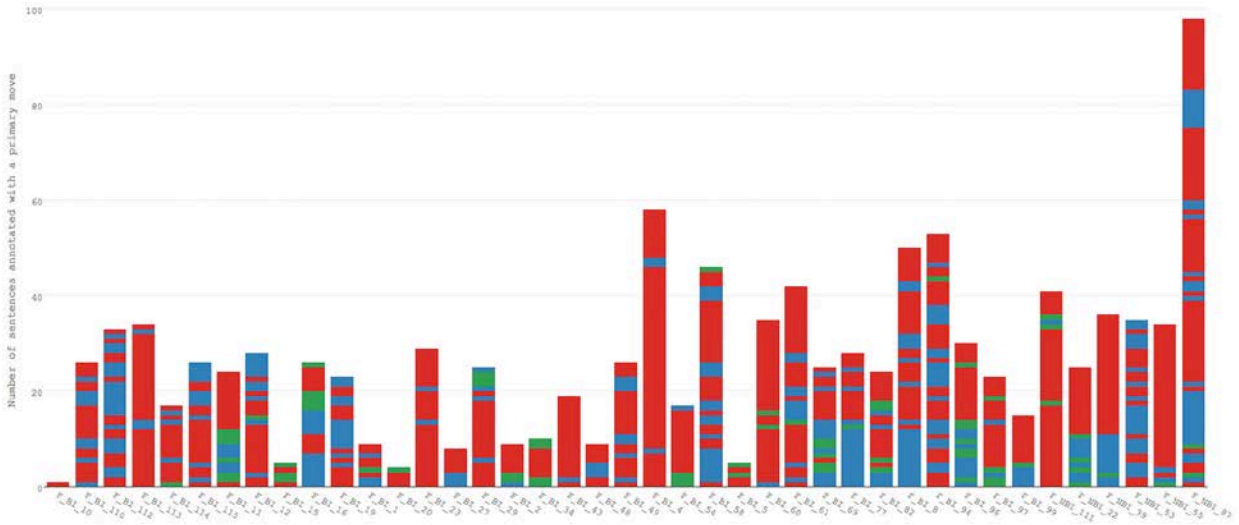

Figure 3b. Move structure of BI sections in funded proposals.

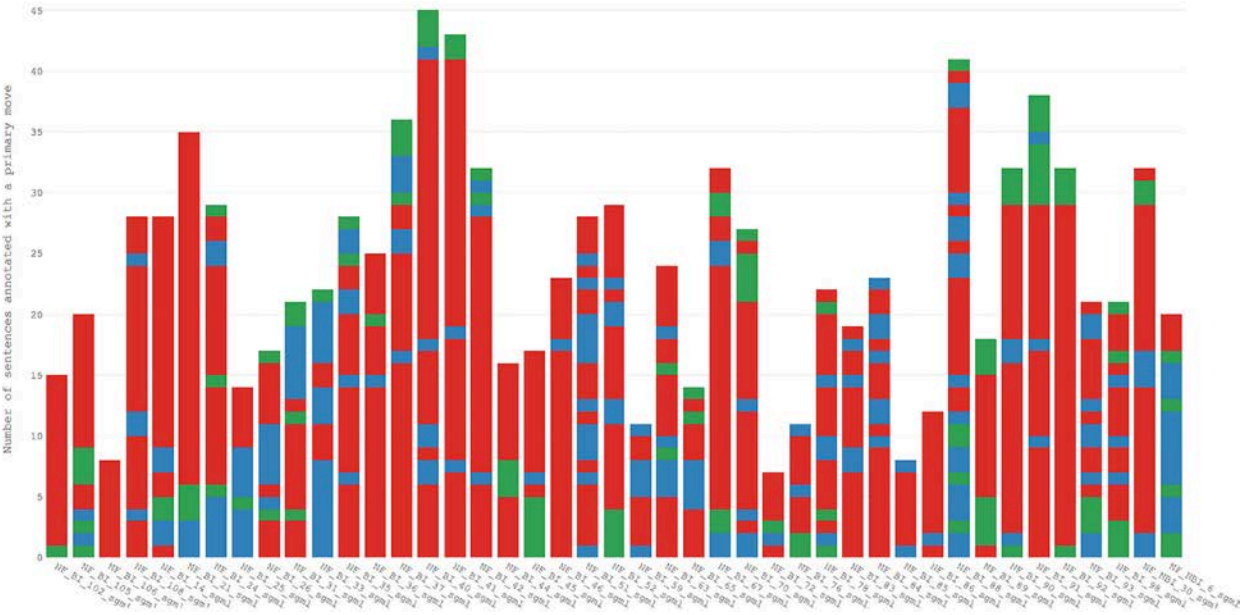

Figure 3c. Move structure of BI sections in non-funded proposals.

Figures 3b and 3c also help identify the co-occurrence and sequence of moves in each sub-corpus. The percentages for co-occurring move pairs, counted sequentially from the first annotated unit on, are not markedly different when comparing funded and non-funded proposals (Table 4). A difference worth mentioning is that in the BIs of funded proposals, Move 1 and Move 2 co-occurred with a comparatively higher frequency, and in this co-occurrence Move 2 was followed by Move 1 46% of the time. In the BIs of non-funded proposals, Move 2 and Move 3 co-occurred slightly more often, with the M2–M3 sequence being more prominent (25%).

Table 4

Move co-occurrences and sequences in BI sections in funded and non-funded proposals.

Co-occurrence	M1 and M2	M1 and M3	M2 and M3

F_BI	68%	15%	18%
NF_BI	59%	16%	25%

Sequence	M1–M2	M2–M1	M1–M3	M3–M1	M2–M3	M3–M2
F_BI	22%	46%	10%	5%	10%	8%
NF_BI	26%	33%	9%	7%	16%	9%

Table 5 further presents how the BI texts opened and closed in terms of moves. From this perspective, the comparison reveals additional similarities and differences. On the one hand, all three moves were used at the beginning of the BIs in both sub-corpora in a relatively comparable way. On the other hand, the use of closing moves differed. In funded proposals, most BIs had Move 2 as the final move (71%). In non-funded proposals, only 51% of BIs closed with Move 2, and another 40% closed with Move 3.

Table 5
Opening and closing moves in BI sections in funded and non-funded proposals.

	Moves	Opening		Closing	
		Percent	Nr of Texts	Percent	Nr of Texts
F_BI	Move 1	32%	13	15%	6
	Move 2	54%	22	71%	29
	Move 3	15%	6	15%	6
NF_BI	Move 1	28%	12	9%	4
	Move 2	49%	21	51%	22
	Move 3	23%	10	40%	17

The results reported above are based on the annotation of full sentences with a primary move. Overall, the distribution of primary BI moves in both funded and non-funded proposals is relatively similar in that M2 was most frequent, M1 was second in frequency, and M3 was the smallest (Table 6). Both the funded and non-funded proposals seem to have approximately the same number of secondary functions of M1; however, there is a difference in the ratio of primary to secondary functions (229/57 vs 177/54). A similar observation can be made for M3, where funded BIs contain a slightly higher number of secondary functions, while the non-funded ones rely more on primary functions to convey the rhetorical intent of M3.

Table 6
Moves coded with primary and secondary functions in BIs of funded and non-funded proposals.

	Funded (41)			Non-funded (43)		
	Primary	Secondary	Total	Primary	Secondary	Total
M1	27% (229)	34% (57)	28% (286)	19% (177)	34% (54)	21% (231)
M2	66% (555)	56% (93)	64% (648)	70% (653)	61% (95)	69% (748)
M3	7% (59)	10% (17)	8% (76)	11% (97)	5% (8)	10% (105)
Total	100% (834)	100% (167)	100% (1010)	100% (916)	100% (157)	100% (1084)

4.2.2. Step distribution

BIs in both sub-corpora contained all the CDP steps (Fig. 4). Independent samples *t*-test yielded no statistical significance when comparing mean frequencies for each move and step in funded and non-funded texts. Yet, two steps – M2/S3, *Asserting competence* (p = .057) and M3/S2, *Envisioning practical contributions* (p = .056) – were identified as close-to-significant pairs. Note that M1/S2 *Claiming centrality* shows a detectable difference; however, it is not statistically significant at the 95% confidence interval (lower difference = -5.02, upper difference = 29.76).

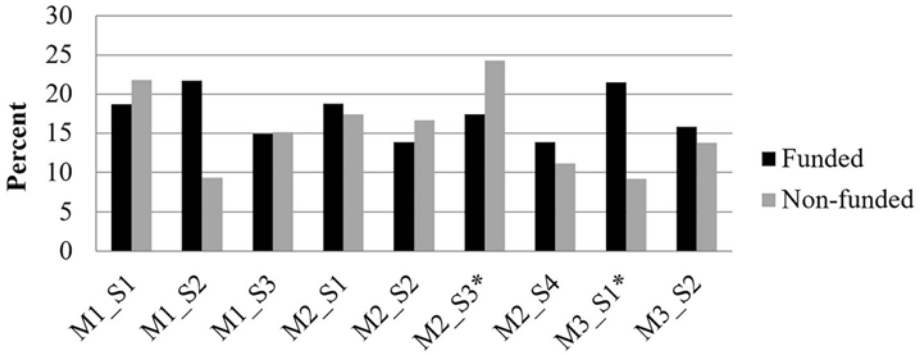

Figure 4. Steps in the BIs of funded and non-funded proposals.

Furthermore, the use of sub-steps in M1 and M2 appears to be similar in funded and non-funded proposals (Fig. 5). M2/S1a, *describing teaching, training and learning*, and M2/S1d, *dissemination*, are more frequent compared to other sub-steps in M2/S1 *Describing BI intent*. M1/S1b, *drawing on a targeted context*, is also more prominent when proposers attempt M1/S1 *Drawing on an established territory*.

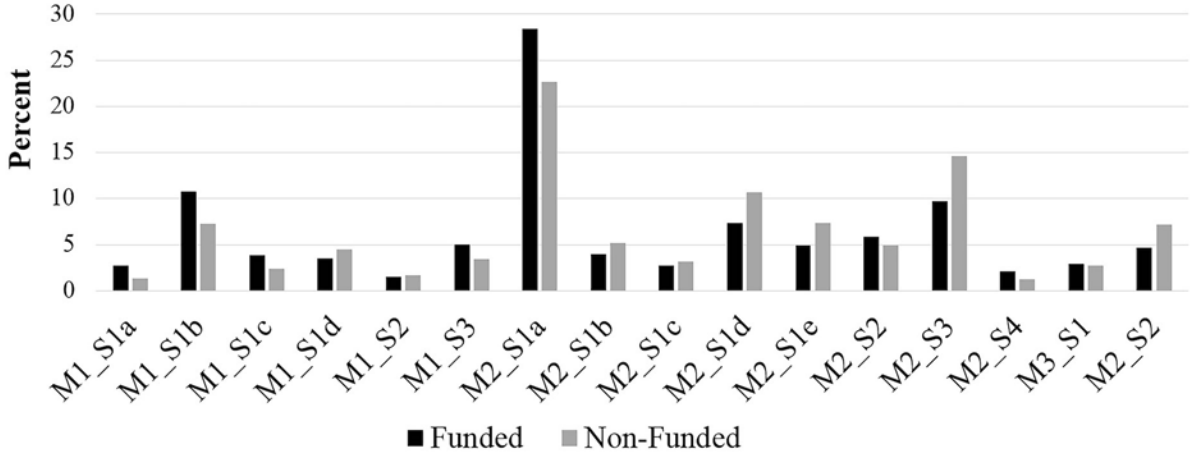

Figure 5. Steps and sub-steps in the BIs of funded and non-funded proposals.

A closer look at the step units coded with primary and secondary tags reveals that funded and non-funded BIs show a comparable distribution, thus indicating similarity in the functional prominence of steps (see Fig. 6). The only noticeable difference is that M2/S4 *Evaluating anticipated impacts* did not occur as a primary function in the BIs of non-funded proposals.

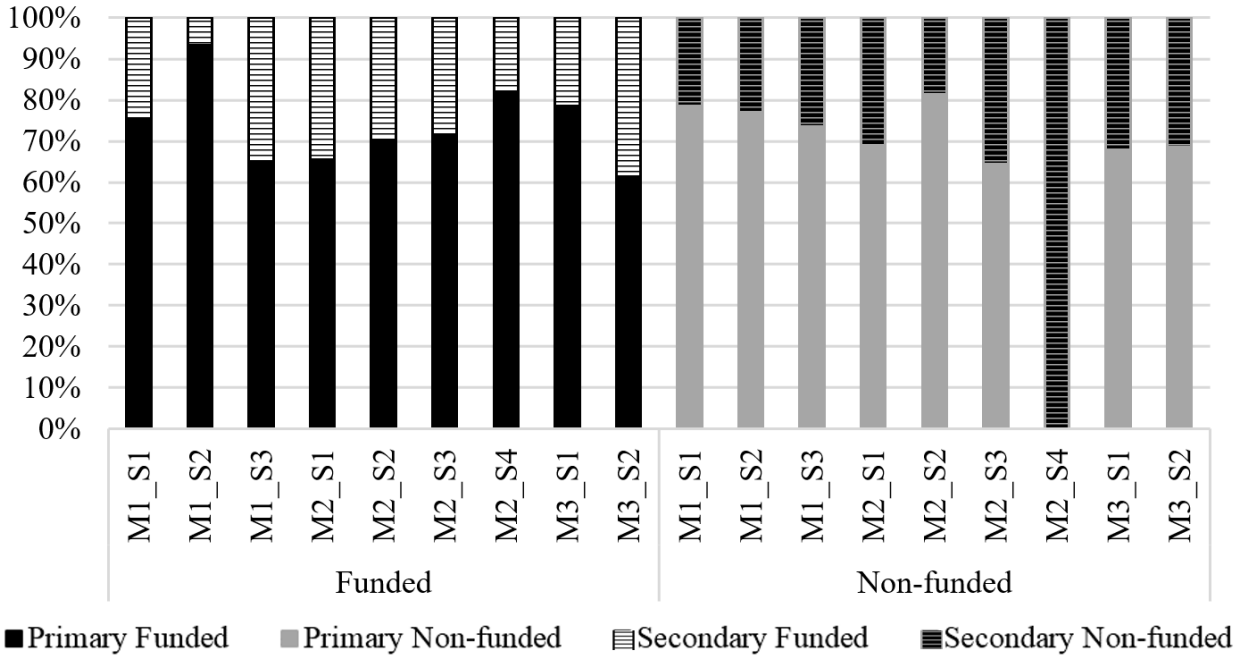

Figure 6. Steps in primary and secondary functions in the BIs of funded and non-funded proposals.

As summarized in Figure 7, BIs in funded proposals contain significantly more primary functions of M1/S2 *Claiming centrality* (p = .033), M2/S1c *Describing infrastructure for research and education* (p = .048), and M3/S2 *Envisioning practical contributions* (p = .037). On the other hand, non-funded BIs contain significantly more of M1/S1b *Drawing on a targeted context* (p = .041) as a primary function. No noteworthy differences were identified for the use of secondary step functions.

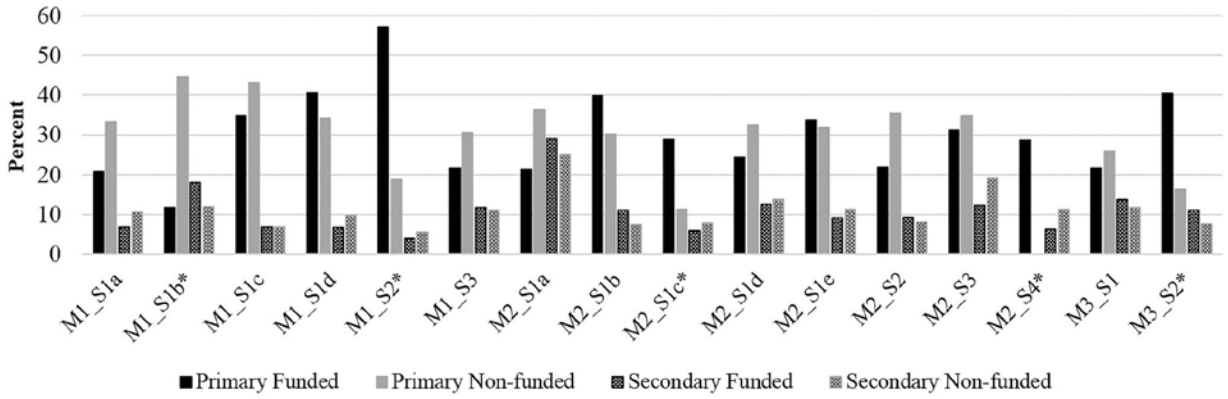

Figure 7. Steps and sub-steps in primary and secondary functions in the BIs of funded and non-funded proposals.

4.2.3. Language use

Tri-gram analysis results were plotted as bootstrap consensus trees, where attention should be

paid to the branches representing the steps within each move that stem from the same node (angles between the branches are not meaningful for interpretation). Figure 8 presents the consensus tree for tri-grams. One can easily identify discrete branch groupings stemming from a common node, e.g. Non-funded M1_S3 and Funded M1_S3. Rendering a large consensus among the individual cluster analyses run in the bootstrap procedure, they indicate that the trigrams were similar in this step of both proposal types (unlike the branches that either have a unique node or are linked directly to the root of the tree). For the purpose of comparing funded and non-funded BIs, it is most relevant to look at the nodes and branch groupings positioned within boxes drawn in Figure 8.

In Move 1, Step 3 was realized with similar language choices in both funded and non-funded proposals, while M1/S1 and M1/S2 are much further apart. What is also interesting is that M1/S1 and M1/S2 in funded texts branch closer together, which may be indicative of more functional overlap between these two steps in the BIs of these proposals. Alternatively, it may be because the same word choices were used with different functional meanings. For instance, trigrams containing such stems as 'essential,' 'critical,' 'significant,' 'importan' occurred when referring to general factual information or important findings reported in previous research (M1/S1), as well as when emphasizing the importance of the topic of the proposed project (M1/S2). For example:

- Example: M1/S1: 'It is essential in a wide variety of uses including an additive in ferric steels, iron castings, metal alloys, paint pigments, glass, catalysts, lubricants, rubber, explosives, and electronics (Hoffmann et al., 2001).' [F_BI_77]
- Example: M1/S2: 'Being in an agricultural state, it is essential to educate our young students about the environmental impacts of nutrient pollution and related control measures.' [F_BI_58]

Similarity in funded and non-funded BIs can also be detected when comparing the n-grams of M2/S1 and M2/S4. On the contrary, the branches of M2/S2 and M2/S3, all stemming from the root, indicate that the n-grams in these steps did not exhibit any consistency in different bootstrap iterations as they positioned in different clusters, which means that the linguistic instantiations were divergent in M2/S2 and M2/S3 of funded and non-funded BIs. Lastly, both steps of Move 3 appear to be linguistically similar in the BIs of both types of proposals as indicated by clear bifurcations in the respective consensus tree.

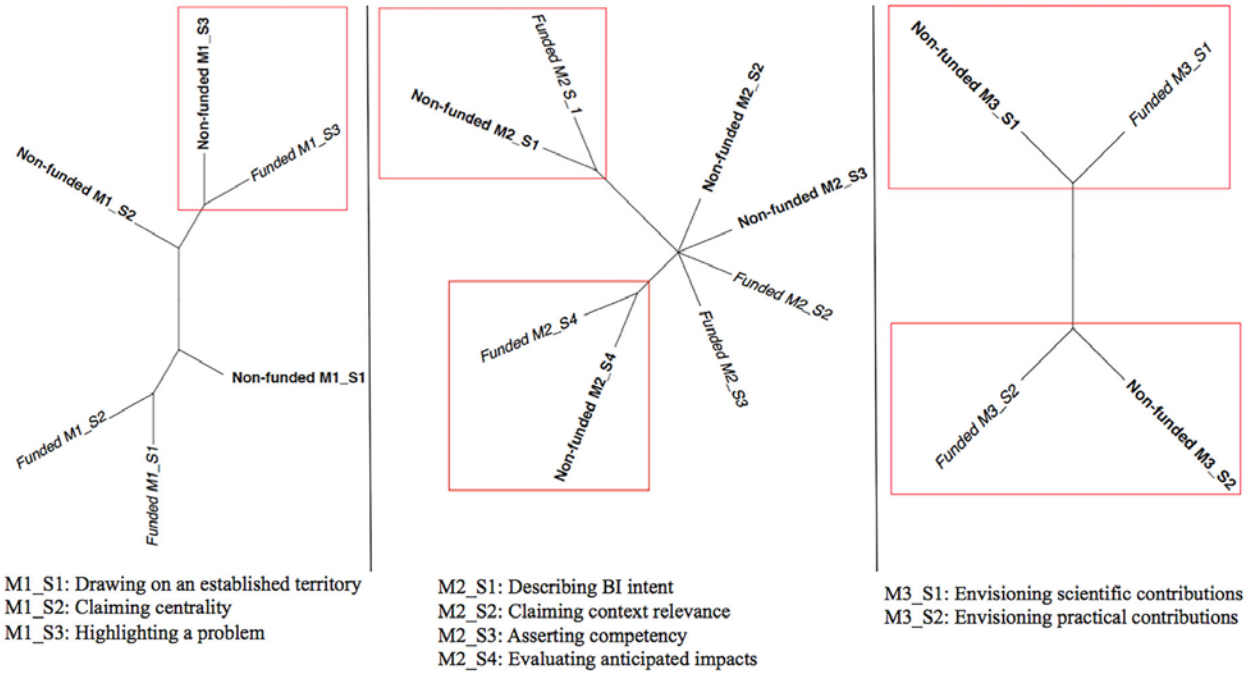

Figure 8. Comparison of language use in the steps of BIs in funded and non-funded proposals.

5. Discussion

The new CDP move/step model presented in this article describes the BI section as a conventionalized part-genre. It comprises some discourse units previously reported for narrative descriptions of grant proposals, abstracts, and summaries. However, unlike the territory, centrality, problem, means, competency, importance, achievements, and contribution moves in grant proposals (see Table 1), BI moves build an argument that emphasizes the potential value of the proposed project to exert short and long term societal benefits rather than the scientific value of expected research results. This underlying difference in orientation towards practice is reflected in BI-specific content. Content-wise, BIs serve as an explicit response to the NSF merit review criteria and guidelines, which indicates the proposers' engagement with the genre set of the funding agency. BI expectations articulated in the NSF's Grant Proposal Guide, in particular, are clearly addressed by the content of *Demonstrating tangible impact* step of M2. Similarly, the two steps of M3 address benefits for the scientific community and benefits for society, respectively.

A parallel can be drawn between the rhetorical resources of BIs and of other comparable genres. Such steps as *Claiming context relevance* and *Asserting competency* of M2 create appeals that resemble promotional genres. The CDP model also features moves and steps characteristic of research articles and academic conference proposals. For instance, *Claiming centrality*, *Highlighting a problem*, and *Drawing on previous research* of M1 mirror the CARS model. *Envisioning practical contributions* and *Envisioning scientific contributions* of M3 are similar to the steps of M4 in Discussion/Conclusions (*Stating the value, Noting implications, and Proposing directions* (Cotos, Huffman, & Link, 2016; Hopkins & Dudley-Evans, 1988). Overall, the structure of BIs can be conceptualized as an hourglass just like the structure of the research article. This correspondence is hardly incidental. It seems that proposers, as scholars who constantly interact with research genres, when writing BIs apply scientific writing conventions

that they have internalized and that are intrinsically accepted by the reviewers, who are reputable scholars themselves.

Compared to other research genres, BIs are much shorter and yet constitute a rich array of rhetorical strategies. Of a total of nine steps, the two steps that are descriptive (M1/S1 and M2/S1) are also the most extensive, *Describing BI intent* constituting about half of the discourse units in the corpus. The other seven steps are clearly persuasive and have relatively similar distributions, which means that proposers infuse rich argumentation to claim the achievement of beneficial societal impact. Therefore, if grant proposals are "the most obvious rhetorical genre of scientific writing" (Myers, 1990, p. 41), BIs are perhaps the most rhetorically charged part-genre.

This study also compared the CDP rhetorical conventions in funded and non-funded proposals. The results showed that BIs in both types of proposals exhibit similar rhetorical composition and internal variation. A notable difference was detected in move co-occurrence and sequencing patterns, as almost half of the proposers whose projects were funded structured their argument by placing a stronger emphasis on M2 tangible impacts and then contextualizing those impacts with M1 step functions. BIs in non-funded proposals, on the contrary, tended to move from M2 tangible impacts to making general claims predicting significance (M3), thus failing to situate their proposed BI activities within an established territory and to present them as means of dealing with an important problem (M1). That being said, although this dissimilarity in argumentation structure was detected, I am not assuming a relation between funding success and writing quality. Going back to the data, two BIs in funded proposals appeared as distinct outliers, one containing only two Move 1 annotated units, and the second containing 97 units marked with different moves (Fig. 3a). Given this variation, it may be inferred that the decision to fund a project or not did not always take into consideration the BI plan, and that the reviewers may benefit from a training in BI writing and analysis as much as the proposers.

Several differences were identified at the level of steps. Unlike the authors of non-funded proposals, the authors of successful grants emphasized more the practical benefits of project outcomes (M3/S2) as opposed to scientific contributions (M3/S1), although this difference was not statistically significant. Roberts (2009), who analyzed BI statements in 294 NSF Project Summaries, also reported that 88% of the proposers who described broader impacts focused primarily on benefits for science. Together, these studies corroborate Lok's (2010) explanation that proposers lack a complete understanding of how to interpret the BI merit review criterion. This issue could be a consequence of how the NSF described the Broader Impacts and Intellectual Merit review criteria. More specifically, Chapter II of the Proposal Preparation Instructions stated that BIs "may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to the project" (NSF, 2016, p. II-10). Intellectual Merit was described as "the potential of the proposed activity to advance knowledge" (NSF, 2016, p. II-9). Both these statements imply research for knowledge advancement. Therefore, it is possible that M3/S1, *Envisioning scientific contributions* appeared common in the BI corpus because many proposers, as researchers, may have perceived benefits from the perspective of science rather than also in more practical terms. Perhaps, M3/S1 would be more suitable for inclusion in the Intellectual Merit section of the proposal.

Another close-to-significant difference worthy of mention is M2/S3, *Asserting competence*, which occurred more frequently in non-funded texts. On the one hand, it may simply indicate proposers' high level of expertise and experience. On the other hand, it may be an attempt to boost credibility in response to some perceived expectations of the funder. For example, a large

portion of BIs elaborated on the prior achievements of principal and co-principal investigators, which seems to address the funder's requirement to report the NSF support received within the last five years. There may be other identifiable connections, so future studies will need to further explore the interaction between the artifacts of the genre set.

A closer look at the step units coded with primary and secondary tags revealed that both types of proposals show a comparable overlap of rhetorical functions at sentence level and both use more primary than secondary step functions. However, the BIs in funded proposals exhibited more functional prominence when *Claiming centrality* (M1/S2) and *Envisioning practical contributions* (M3/S2). This may make the overall argument more persuasively effective. Another important finding is that non-funded proposals lacked M2/S4, *Evaluating anticipated impacts* as a primary function, which makes this communicative intent less explicit.

6. Conclusion

Utilizing the framework of Swalesian genre theory, this article characterizes the rhetorical resources that grant seekers employed to persuade the NSF funding agency of impactful societal benefits of their proposed work. Like Connor and Mauranen (1999), I would contend that the CDP moves and steps do not represent an ideal list of persuasive and communicative techniques; rather, they should be viewed as "constraints and expectations" (see Connor & Mauranen, 1999, p. 49) that function as a framing schemata for new proposals' BIs. It would be interesting to further explore whether the structural and linguistic constraints are particularly salient when broken, as Bhatia (1993) suspects. Proposal reviewers would be a highly informative source for such research. Given that textual reception and production may not clearly align when a reviewer reads a grant application (Tseng, 2011) and that "genre systems play an intermediate role between institutional structural properties and individual communicative action" (Berkenkotter, 2001, p. 329), correspondences between move analysis and reviewer expectations may not always be direct and transparent. Acquiring an understanding of the communicative goals in view of these correspondences is imperative to comprehensively describe BIs as social action. The CDP model, being the first attempt to identify BI textual conventions, should be viewed as illustrative rather than definitive, motivating further analyses of this high-stakes part-genre to expound its dynamic nature in fluctuating contexts.

The comparison of BIs in funded and non-funded proposals revealed some regularities and variation, which could be indicative of both constraint and choice. While disciplinary norms and expectations may account for the internal variation, drawing far-reaching conclusions is not warranted particularly because this study did not examine proposals per discipline. This is a limitation that could not be accounted for here; future studies will benefit from close collaboration with disciplinary experts in exploring discourse features at both macro and micro levels.

Returning to the initial motivation for the study, the CDP model is recommended for designing guidance materials on how to effectively describe the BI activities of research projects. So far, the NSF's scholarly community has benefitted from resources aimed to help researchers develop BI plans that best reflect the interests and goals of their proposed projects (e.g., guiding principles and questions, planning and evaluation guide-sheets and toolkit, online Broader Impact Wizard application, searchable database containing informational links and scholarly

articles on various aspects of the NSF's BI criterion, etc.).[7] The results of this study provided the stepping stones for similar resources on BI writing. New workshops for faculty have been successfully implemented at Iowa State University, at the University of Missouri, and at the NSF's EPSCoR (Established Program to Stimulate Competitive Research) Annual All-Hands Meeting in Iowa. Materials based on the CDP model have also been disseminated on public websites.

Like faculty, graduate students are increasingly expected to communicate the anticipated impact of their thesis or dissertation beyond the technical aspects. The ability to develop and articulate efforts to potentially benefit society and contribute to the achievement of desired societal outcomes are highly desirable traits in the new generation of scientists, engineers, and academics. Looking forward, a series of educational and support systems can be also be devised for students. The annotated corpus could serve as a unique resource for creating example materials for pedagogic use, which according to Flowerdew (2016) are hard to find.

While the CDP model is recommended for designing educational and professional development resources and activities, it must be reiterated that the BI principle is only one of the evaluation criteria. It would certainly not be unexpected if proposals lacking meaningful BIs are not funded, and effective BIs may weigh in on borderline decisions; however, a perfectly argued BI section does not necessarily guarantee a successful proposal. The reasons for rejection may be associated with a variety of factors, including external or idiosyncratic factors (e.g., soundness of proposed research, level of competitiveness, reviewers' possible biases, timing, budget planning, etc.). Therefore, educational applications should treat grant writing as a genre system, methodically combining formal conventions (Cotos, 2018) and complementary apprenticeship approaches (Ding, 2008) to enable systematic incorporation of resources inside and outside learning environments. Specifically, move/step models such as the ones discussed in this article could enhance cognitive apprenticeship through modeling, scaffolding, and coaching in formal settings. Social apprenticeship, in turn, would offer opportunities for informal socialization with expert stakeholders and observation of their behaviors to introduce grant writers to the hierarchy of writing tasks and changing roles, and ultimately empower them to produce effective proposals.

Funding

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[7] See https://broaderimpacts.net/wp-content/uploads/2016/05/nabi_guiding_principles.pdf, https://www.grantshub.iastate.edu/wp-content/uploads/2016/05/Broader-Impacts-Planner.pdf, http://theconnector.missouri.edu/wp-content/uploads/2017/10/Connector_Guidesheet-1.pdf, http://research.missouri.edu/about/files/Evaluation_101.pdf, http://coseenow.net/wizard, and https://www.spisu.iastate.edu/resources.

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Appendix A. Examples of Broader Impacts activities provided by NSF

The activities were structured according to the following questions:

1. How well does the activity advance discovery and understanding while promoting teaching, training and learning?
2. How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)?
3. To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks and partnerships?
4. Will the results be disseminated broadly to enhance scientific and technological understanding?
5. What may be the benefits of the proposed activity to society?

The following activities served as examples for addressing question 1 above:

- Integrating research activities into the teaching of science, math and engineering at all educational levels,
- Including students at different educational levels and from different majors as participants in the proposed activities,
- Recruiting, training, or engaging K-12 teachers in professional development,
- Designing research-based educational materials or contributing to teaching databases or digital libraries,
- Partnering with researchers and educators to incorporate research into teaching and learning,
- Engaging students in the activities of professional societies,
- Establishing special mentoring programs for students at different educational levels,
- Involving graduate and post-doctoral researchers in undergraduate teaching,
- Developing, adapting, or disseminating effective models and pedagogic approaches to science, mathematics and engineering teaching.

Appendix B. Brief annotation protocol and procedure

General annotation guidelines

- Read the entire text for general understanding.
- Identify segments of the text based on their roles in achieving the communicative goals of the moves.
- Examine those segments more closely with a functional-semantic focus to distinguish the steps. For that, determine what a text segment is doing functionally to contribute to the move.
- Segment the text into units of annotation, defined as a functional segment of text. Determine the functional meaning of the text segment and annotate it with the respective step of a given move. Use the descriptors of functional and content realizations (see Appendix C). Look for specific language choices that signal rhetorical intent (e.g., "*The proposed research will investigate*" and "*See the attached letter of collaboration from*" indicate the function of M1/S1d: 'Drawing on current proposal'). Also, consider content clues, as rhetorical intent is not always explicitly articulated (e.g., *Currently our students are exposed to […] in three courses: at the freshman level, sophomore level and finally the capstone […] course at the senior level* indicate the function of M1/S1a: 'Drawing on real-world context').
    - Begin at sentence level, as the unit of annotation may be a full sentence, a clause, or a phrase within a clause. Identify the functional meaning of the sentence and annotate it with a primary step and move.
    - If a sentence conveys more than one functional meaning, identify its secondary step function and which segment carries that meaning. Annotate that segment with a secondary step and move. (e.g., *"Given the significant impact of extreme events on both the natural environment and society, the results of this research will be of interest to policy makers, governments and scientists across a wide range of disciplines."* – the entire sentence should be annotated with the primary function of M3/S2 'Envisioning practical contributions'; the phrase *"the significant impact of extreme events on both the natural environment and society"* should be annotated with the secondary function of M1/S2 'Claiming centrality').
    - When a sentence is composed of coordinate clauses, tag them with the same primary step and move if they carry the same functional meaning, and with different primary steps and moves if their functional meanings are different.
    - When a sentence contains subordinate or embedded clauses, tag the entire sentence with a respective primary step and move if the subordinate or embedded clause carries the same functional meaning as the main clause, and with different secondary steps and moves if their functional meanings are different from the main clause.
- Verify the boundaries of the annotation unit/s, especially for segments with secondary functions, by identifying which linguistic or content feature/s is/are clearly indicative of the function.
- Record representative examples of linguistic instantiations of steps/moves.
- If the function of a segment is not clear, flag it for discussion and clarification during the following adjudication session.

Adjudication guidelines for calibration and resolution of annotation issues

- Structure the files for calibration and adjudication as follows (in Excel):
    - Column 1: text ID
    - Column 2: number of paragraph
    - Column 3: number of sentence
    - Column 4: text segment
    - Column 5: Annotator 1 sub-columns
        - Primary step and move
        - Secondary step/s and move/s
    - Column 6: Annotator 2 sub-columns
    - Column 7: final adjudicated annotation
        - Primary step and move
        - Secondary step/s and move/s
- In Columns 5 and 6, highlight cells if Annotator 1 and Annotator 2 disagreed.
- In Column 4, color-code segments with secondary function/s (blue for move 1, red for move 2, green for move 3).
- In cases of both annotator agreement and disagreement, explicitly rationalize why each annotated unit carries a particular function. In cases of disagreement, discuss till a consensus is reached.
- Discuss annotated units that lack rhetorical signals but implicitly convey functional meaning.
- Explain why a text segment may be unclear and clarify the meaning.
- Explain why a text segment may be ambiguous and resolve ambiguity.
- Discuss text segments that do not seem to overtly fit within a step/move and justify the decision to annotate with a particular step/move.
- Address rhetorical overlap of steps/moves.

Appendix C. Descriptors of functional and content realizations of the steps in Broader Impacts sections

Move 1: Contextualizing Potential Impacts

Functional realizations	***Content realizations***	***Examples***
Step 1a: Drawing on a real-world context Situates the proposed BI activities in the world outside the proposed research project.	- providing relevant general information, - providing relevant domain-specific information, - providing information regarding current state/ national/global policies and decisions, - providing facts or statistics from credible sources, (without attribution to research findings or publications, but may have citations from non-research documents).	• *They are found in three different families not related by amino acid sequence.* • *U.S. efforts to reduce its dependency on foreign crude oil through the use of domestic biofuel production are defended on three grounds: national security, energy security, and environmental protection.* • *The U.S. reserves of […] (~ 14% of world's reserves) are about 3,000 metric tons (http://www....).*
Step 1b: Drawing on a targeted context Situates the proposed BI activities in a specific, targeted context for the proposed research or BI plan.	- describing the current activities of the PIs (e.g., a course the PI is teaching), - describing the current activities of the project participants as well as of representative student groups (e.g., completed assignments), - describing the structure, functionality, composition, role, of participating units (e.g., organization, program, club), - describing available resources and facilities, - describing ongoing and/or future projects in the targeted context.	• *PI […] teaches the sophomore-level […] with an average enrollment of […] students per semester.* • *Currently our students are exposed to […] in three courses: at the freshman level, sophomore level and finally the capstone […] course at the senior level.* • *[…] also provides professional development seminars for undergraduates interested in a research career.* • *In this school district, […%] of the students participate in the free and reduced meal program.*
Step 1c: Drawing on previous research	- referring to research knowledge in the field,	• *Small […] viruses such as […] provide a viable alternative to the application of […] for […] management (20, 44).*

Situates the proposed project and/or BI activities in a given research space by providing empirical background to the topic of investigation.	- referring to preliminary research conducted by the proposers in preparation for the grant.	• *This is a follow-up of an earlier experiment in which we found that […] caused lower reductions in […] than […] when each species was seeded three weeks before other species (Author, Author and Author in preparation).*
Step 1d: Drawing on the current proposal Establishes relevant connections to the current proposal.	- restating the purpose of proposed research, - referring to methodology of proposed research, - rationalizing and justifying the methodological approach, - referring to content/material presented elsewhere in the proposal, - showing relevance of proposed work vis-s-vis NSF's goals or other standards.	• *The proposed research will investigate the capability of the […] generation of […] to simulate extreme daily […] and its […] causes.* • *A second benefit of this approach is that it demonstrates that a common set of experiences can have widespread effects within the same individuals.* • *See the attached letter of collaboration from the director of […]' […] Program.*
Step 2: Claiming centrality Affirms that the topic/problem addressed in the proposal is important.	- arguing that there is a considerable degree of interest in the topic/problem, - indicating that the topic/problem/proposed idea/activity is of great importance, - indicating how prominent the topic/problem has become.	• *This is of the utmost importance as contemporary […] are not only expected to possess technical expertise but to integrate science and technology into society as a whole.* • *[…] is the essential component of […], our nation's key infrastructure component.*
Step 3: Highlighting a problem Specifies a problem in the established territory that causes challenges to particular areas of practice and emphasizes the importance of addressing it.	- stating the problem (e.g. controversy at national/societal level, difficulty in finding alternatives or solutions, limitations of previous research, practical challenges, potential negative impacts), - predicting consequences of the problem, - justifying the need to address the problem (may sound like a call for action).	• *However, in full recognition and admiration of the […]'s noble effort, this […] regulation could also cause substantial harm to the American public.* • *While […] is a fairly common method for increasing […], very few […] projects result in a production of an "engineering roadmap" for use by others.* • *If policy makers and land managers are to address these changes effectively and move our […] toward a positive future, they need to*

		understand how these […] affect local processes and which policies and decisions lead to outcomes that are sustainable, resilient, and preserve the adaptive capacity needed to adjust to new and unforeseen threats and opportunities.

Move 2: Demonstrating Tangible Impacts

Functional realizations	***Content realizations***	***Examples***
Step 1: Describing BI intent Proposes and elaborates on specific BI activities, which are expected to exert tangible impacts in the targeted context/s.	- announcing representative BI activities related to: teaching, training and learning, participation of underrepresented groups, infrastructure for research and education, partnerships between academia, industry, dissemination, benefits to targeted individuals/groups, other. - specifying details and clarifying means that will be employed to accomplish the objectives of the BI activities, - specifying deliverables.	• *We will work closely with […] and […] in the […] to recruit participants from underrepresented groups who will engage in semester research experiences and as summer field research assistants.* • *Using hands-on activities, […] methods, and field study, students will explore the diversity of […] and their use as […] of […] quality.* • *In addition to providing collaborative links between [..] and […], this project will enhance infrastructure by providing for interactions between members of […] and members of […], which will foster interdisciplinary approaches to […] questions.* • *A second outcome of Study 1 will be the […] Handbook (DHH), which will guide educators in how to use […] within their classrooms with students of different cognitive styles.*
Step 2: Claiming context relevance Demonstrates that the targeted context/s is/are appropriate for successful implementation of the proposed BI activities.	- describing local programs, initiatives, courses, resources, technologies, equipment, products, etc., - describing existing relationships with partnering groups/organizations	• *[…] University has a strong history of promoting the participation of underrepresented groups, as demonstrated by its […] program linked to underrepresented groups in inner-city schools.* • *For those who wish to remain in academia, […] offers a comprehensive and intensive […]*

	- providing evidence of interest/support from partnering organizations.	*program that includes training in […] skills, […], and […] management.* • *The workshop will take place in a state-of-the-art teaching/research classroom.*
Step 3: Asserting competency Provides evidence of competency acquired by the project proposers and/or participants, which underscores the potential success of the BI activities.	- claiming reputation/skills/experience, - providing evidence of research excellence, - describing mentoring/teaching experience, - providing evidence of impacts from previous grants and other achievements, - describing the achievements of mentored students, - describing initiated and/or maintained collaborations.	• *The PIs are leading faculty in the […] center.* • *PI's efforts […] were recently recognized by an award from […].* • *The three most recent undergraduate women who worked in the PI's lab are all pursuing careers in […]; two are graduate students at […] and one is a postdoc at […].* • *PI […] has been highly successful in obtaining extramural grants and establishing collaborations with other […] experts and leading […] around the globe.*
Step 4: Evaluating anticipated impacts Indicates how the effects of the proposed BI activities will be assessed.	- describing evaluation measures, - making predictive claims of effectiveness of BI activity outcomes, - implicitly indicating potential for success.	• *Since we will have "traditional" course sections in […] being taught in parallel with the […] sections, we will at one level evaluate student performance in […] by doing comparative testing during the semesters and at the finals.* • *We fully anticipate the female participation to increase significantly as the […] courses are more widely advertised across campus to the […](…% female) as well as […] (…% female) colleges.*

Move 3: Predicting Significance

Functional realizations	***Content realizations***	***Examples***
Step 1: Envisioning scientific contributions	- predicting notable advancements in the research field, - anticipating utility/applicability of findings for future research.	• *The proposed […] framework will bring to the science community a new perspective and an invaluable tool for studying the functions of […] that are constantly in motion.*

Claims significant value of the new scientific discoveries to the research field.		• *Collectively, these investigations will allow for the development of a detailed description of the […] and […] activity, and consequently more accurate descriptions of […] can be developed in future research projects.* • *Hence, our work may synergize with research geared toward management of […].*
Step 2: Envisioning practical contributions Claims significant potential to advance desired societal outcomes.	- predicting contributions of science to real world needs (e.g. to national/societal welfare, security, public policy, health, environment, critical situations, decision-making), - suggesting applications of research project developments and outcomes, - specifying the direction in which the contribution will be made.	• *In addition, this research will help […] businesses, governmental agencies, and non-governmental organizations deal with conflict and miscommunication when working in collectivist, honor-based cultures.* • *This will transform […] design the same way the design of […] was revolutionized because of these technologies' low-power fast-switching capabilities.* • *It has direct implications for the quantification and stability of […] that is buried by […] as well as development of cost-effective techniques to quantify stable […] in […] in general.*

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